Geological Survey
of Canada

Current Research
2001-D10

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2001

Natural Resources Canada Ressources naturelles Canada

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Catalogue No. M44-2001/D10E
ISBN 0-660-18436-2

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101-03634/

The unconformable character and paleogeographic significance of the Chazy–Black River group contact, Montréal area, southwestern Quebec[1]

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Salad Hersi, O., and Lavoie, D., 2001: The unconformable character and paleogeographic significance of the Chazy–Black River group contact, Montréal area, southwestern Quebec; Geological Survey of Canada, Current Research 2001-D10, 10 p.

Abstract: An unconformity marks the Chazy–Black River group contact in southwestern Quebec. It is characterized by an eastward pinching out of the Pamelia Formation (Black River Group), borings, and truncation of the Chazy strata. Coarse-grained sandstone of the Pamelia Formation or Lowville Formation (where the former is missing) lies above the contact. Lithological differences between dolostone units in the Laval (Chazy Group) and Pamelia formations were recognized, allowing us to better position the contact. The Pamelia Formation (44 m thick) in eastern Ontario conformably overlies the Chazyan strata. From Montréal to Québec progressively younger Black River strata onlap older rocks. This onlapping is accompanied by substantial lithological changes where sandstone and different limestone lithofacies are preserved. These variations suggest a more limited accommodation space for the Black River strata in southwestern Quebec, and, therefore uplifting relative to eastern Ontario. This uplifting is probably due to old structural lineaments reactivation by the then ongoing Taconian Orogeny, and may indicate an incipient upthrow of the Beauharnois anticline.

Résumé : Une discordance marque le contact entre les groupes de Chazy et de Black River dans le sud-ouest du Québec. Ce contact est caractérisé par l'amincissement progressif vers l'est jusqu'à disparition de la Formation de Pamelia (Groupe de Black River), par la présence de terriers et par le recoupement des strates du Groupe de Chazy. Du grès grossier de la Formation de Pamelia ou de la Formation de Lowville (là où la première est manquante) repose sur le contact. Des différences lithologiques entre les unités de dolomie dans les formations de Laval (Groupe de Chazy) et de Pamelia ont été reconnues et nous permettent de mieux situer le contact. La Formation de Pamelia (44 m d'épaisseur) dans l'est de l'Ontario repose en concordance sur les strates du Groupe de Chazy. Depuis Montréal jusqu'à Québec, des strates de plus en plus jeunes du Groupe de Black River forment un biseau d'aggradation sur des roches plus anciennes. Ce biseau est accompagné de changements lithologiques importants aux endroits où sont conservés du grès et divers lithofaciès de calcaire. Ces changements lithologiques indiquent qu'il y avait moins d'espace pour les strates du Groupe de Black River dans le sud-ouest du Québec et, par conséquent, qu'il y a eu soulèvement par rapport à l'est de l'Ontario. Ce soulèvement serait attribuable à la réactivation d'anciens linéaments structuraux par l'orogenèse du Taconique en cours à ce moment et atteste peut-être d'un début de soulèvement vertical de l'anticlinal de Beauharnois.

[1] Contribution to the Appalachian Foreland and St. Lawrence Platform NATMAP Project

INTRODUCTION

One of the major problem when dealing with the St. Lawrence platform in southern Quebec is the fact that most of the group units used were defined in upstate New York by paleontologists with limits put at faunal changes. This biostratigraphic approach has been entrenched in the geology of the platform since the early part of the twentieth century as subsequent mappers were mostly biostratigraphers and the use of bio- and chronostratigraphic units as formal, mappable lithostratigraphic groups has been the norm, with, for some units, no significant lithological changes on both sides of group contacts. It is not our intention, for now, to redefine lithostratigraphic units, although some confusion might arise in the use of the stage versus the lithostratigraphic designation of rock units. As it is currently understood in southern Quebec, the 'Chazyan' and 'Blackriveran' refer to a rock package defined as a lithostratigraphic group (Chazy and Black River) which correspond to their equivalent chronostratigraphic stages.

The contact between the Chazy and Black River group strata of the Quebec Re-entrant (the Ottawa Embayment of eastern Ontario and southwestern Quebec) is documented to be apparently conformable in eastern Ontario to possibly unconformable in the region of Montréal, southwestern Quebec (Okulitch, 1936; Salad Hersi et al., 1998; Salad Hersi and Dix, 1999). The conformable to unconformable transition from eastern Ontario to southwestern Quebec is not, however, clear due to post-Ordovician erosion of the Black River strata between the outcrops in Montréal and in eastern Ontario regions (Fig. 1). In the region of Montréal, Okulitch (1936) indicated an erosional disconformity between the Chazyan Laval Formation and the Blackriveran Pamelia Formation. Chazyan–Blackriveran paleogeographic reconstrutions of the Ottawa–Montréal region (Salad Hersi, 1997; Salad Hersi et al., 1998; Salad Hersi and Dix, 1999; Salad Hersi and Lavoie, 1999, 2000) were partly based on Okulitch's (1936) data on this boundary; however, this unconformity was poorly defined, and most of the later researchers (e.g. Clark, 1972a, b; Hofmann, 1972; Globensky, 1987) did not support the existence of such an unconformity. Instead, these researchers proposed a continuous transitional boundary between the Chazy and the Black River group strata in the Montréal region. We examined the Chazy–Black River group contact in the Montréal–Joliette region with great details from five quarries (localities 1–4, and 6, Fig. 1) and one well core (locality 5, Fig. 1). Our conclusion strongly supports the existence of a disconformable contact. We describe here the nature of this boundary and its paleogeographic significance during the late Chazyan to early Blackriveran stages.

REGIONAL GEOLOGY

The Paleozoic sedimentary cover in the western part of the Quebec Re-entrant (the Ottawa Embayment of eastern Ontario and southwestern Quebec) includes Sloss' (1963) Sauk and Tippecanoe sequences. The former is Cambrian to Early Ordovician, and includes the Potsdam and Beekmantown groups which accumulated during the rifting and drifting phases of the Iapetus Ocean (Bernstein, 1991). The Tippecanoe sequence is Middle to Late Ordovician and developed in a foreland basin setting. This latter sequence comprises 1) lower siliciclastic-dominated Rockcliffe and Hog's Back formations in eastern Ontario that transitionally merge with carbonate-dominated Laval Formation in western Quebec (Wilson, 1946; Clark, 1972a; Salad Hersi and Dix, 1997), 2) a middle carbonate-dominated Ottawa Group and its equivalent "Black River and Trenton" groups in western Quebec (Clark, 1972b; Salad Hersi, 1997), and 3) an upper siliciclastic assemblage of the Billings, Carlsbad, and Queenston formations (Williams, 1991) and the equivalent Utica and Lorraine groups in southwestern Quebec (Clark, 1972b). The upper siliciclastic units represent westward-prograding, orogen-derived terrigeneous materials that caused the shut-down of Late Ordovician carbonate 'factory' and the foundering of St. Lawrence platform during the Late Ordovician.

PREVIOUS WORK

Previous conclusions on the Chazy–Black River group boundary in southwestern Quebec can be grouped into two models: 1) a disconformable contact envisaged by Okulitch (1936), and 2) a transitional conformable one adopted by most of the later researchers including Hofmann (1963, 1972), Clark (1972a, b), Harland and Pickerill (1982), and Globensky (1987). Okulitch (1936) indicated that a disconformable contact between strata of Chazyan and Blackriveran ages at Saint-Vincent-de-Paul quarry in Laval separates black shale units of Laval Formation from "sandy, magnesian limestone" of basal Pamelia Formation; however, Okulitch (1936) did not further elaborate the nature of this boundary stating, "The erosional disconformity is masked over the greater part of the contact by the shaly nature of the upper Chazy, but the sand in the lowest Pamelia is an additional indication of its presence."(p. 128). In the region of Trois-Rivières, about 120 km further northeast of Montréal, Roliff (1967) indicated that the Chazyan–Blackriveran strata are locally separated by an angular unconformity. In the Joliette area, Clark and Globensky (1976a) concluded that the Pamelia Formation is missing and that the Lowville Formation overlies the Joliette Member of the Laval Formation. We mapped one of the quarries in the Joliette region (locality 6, Fig. 1), agree with Clark and Globensky's (1976a) work, and will show details of this contact in this paper (*see* below).

The second group of researchers proposed a transitional contact between the Chazy and the Black River group strata. Hofmann (1972, p. 6) stated, "In the uppermost parts [of the Laval Formation], calcisiltite and shaly dolomitic beds are transitional into the overlying Pamelia dolomites." In an earlier work, Hofmann (1963) used a biostratigraphic approach for the recognition of the Laval–Pamelia contact. Hofmann (1963, p. 273) states that this contact lies "...at the top of the highest unit in which this brachiopod [i.e. *Rostricellula plena*] occurs abundantly, below the first dolomite bed of the "Pamelia" formation." Despite this biostratigraphic approach

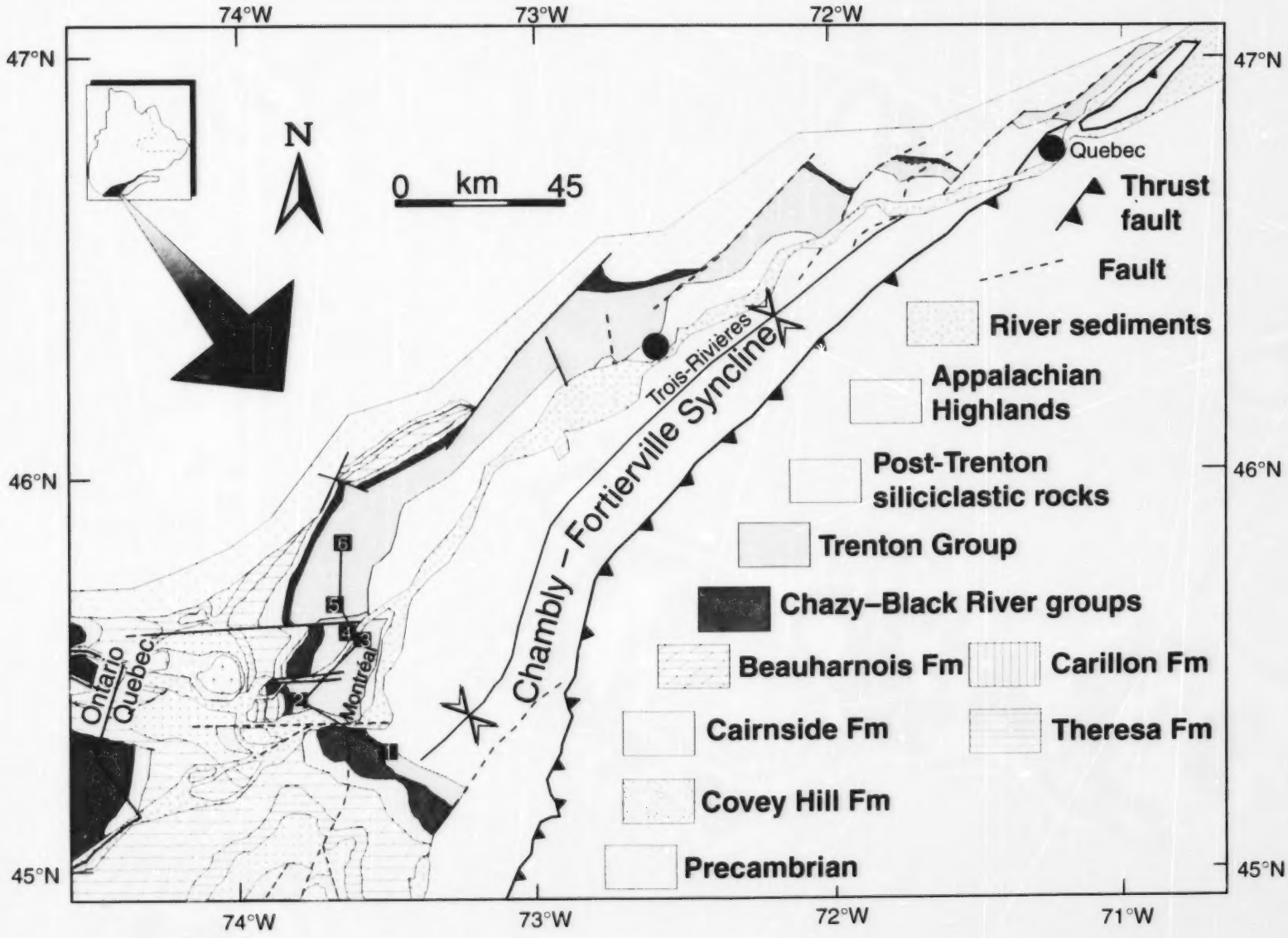


Figure 1. *Geological map of southwestern Quebec with locations of sections mentioned in the text. Note that the Chazy–Black River strata are eroded in most parts of the Quebec region west of Montréal obscuring the transitional nature of the these strata and their contact from sections in eastern Ontario and those addressed in this study.*

to separate the two "formations", Hofmann (1963) acknowledged that the same brachiopod occurs within the dolostone units of the Pamelia Formation in some places (e.g. the Devito quarry at Pointe-Claire). We mapped Hofmann's (1963) Pointe-Claire quarry (locality 2, Fig. 2), and include much of his "Pamelia Formation" to the Laval Formation (*see* below for further details).

CHAZY–BLACK RIVER CONTACT IN THE MONTRÉAL REGION

It is generally accepted that the upper part of the Laval Formation becomes more dolomitic which makes it difficult to differentiate from the overlying dolostone units of the Pamelia Formation (Hofmann, 1972; Clark 1972a, b; Clark and Globensky, 1976a). Therefore, the exact location of the contact becomes arbitrary; however, our field mapping allowed us to differentiate the two dolostone units across the contact. We mapped six sections which range across the Chazy–Black River boundary (Fig. 1). These sections are from the Lafarge quarry at Saint-Constant (locality 1), the Meloche (abandoned) quarry in Kirkland, Montréal Island (locality 2, previously known as Pointe-Claire quarry), the Miron quarry (abandoned, and now used for dumping site by the municipality of Montréal, locality 3), the Saint-Vincent-de-Paul quarry (abandoned, and now Centre de la Nature) in Laval (locality 4), a core from a well drilled at Côte Saint-Louis (locality 5), and the Saint-Laurent cement quarry at Joliette (locality 6). Figure 3 shows the stratigraphic columns logged from these sections; lithology of the strata across the contact is given below.

Locality 1: Lafarge quarry at Saint-Constant

The section exposes a thick section of Laval Formation, the overlying Black River strata, as well as the lower part of the Trenton strata. This section is important for the understanding of the lithological nature of the upper Laval Formation in order to compare with the other studied sections. The upper part of the Laval Formation at the Lafarge quarry consists of three lithofacies. 1) The first is light- to medium-grey, coarse-grained, bioclastic lime packstone to grainstone (the typical St. Martin calc-arenite facies of Hofmann (1963)). The unit is either clean, crossbedded limestone or has irregular, shaly laminae resulting a nodular lithofacies. Bioclasts are dominated by brachiopods (specially *Rostricellula* sp.), bryozoans, trilobites, algae, and crinoids. 2) Medium brownish-grey, moderately to well burrowed, medium- to coarse-crystalline, bioclastic to nonbioclastic dolomudstone to wackestone is the second lithofacies. Lenses to irregular zones of bioclastic, dolomitic lime packstone are locally present within this dolostone lithofacies. Burrows are mostly horizontal and locally very abundant giving the rock a dense, mottled appearance. Bioclasts are similar to those present in the above-mentioned limestone lithofacies. 3) The third lithofacies in the upper part of the Laval Formation is light to medium, brownish-grey dolomitic shale. It contains small,

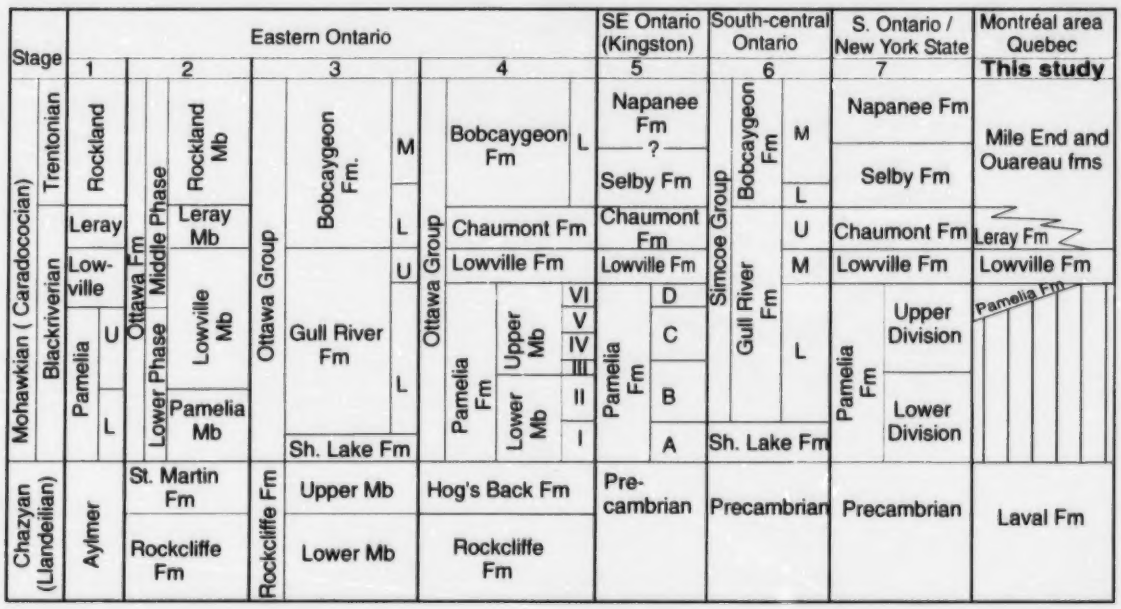


Figure 2. *Chart showing stratigraphic nomenclature of the Chazyan, Blackriveran, and lower Trentonian succession in the regions of Montréal; eastern, southeastern, and south-central Ontario; and upstate New York, U.S.A. The numbers at the top of each column indicate authorship: 1 = Raymond (1914), 2 = Wilson (1946), 3 = Williams (1991), 4 = Salad Hersi and Dix (1999), 5 = McFarlane (1992), 6 = Liberty (1969), 7 = Kay (1929), Young (1943a, b), Cameron and Mangion (1977).*

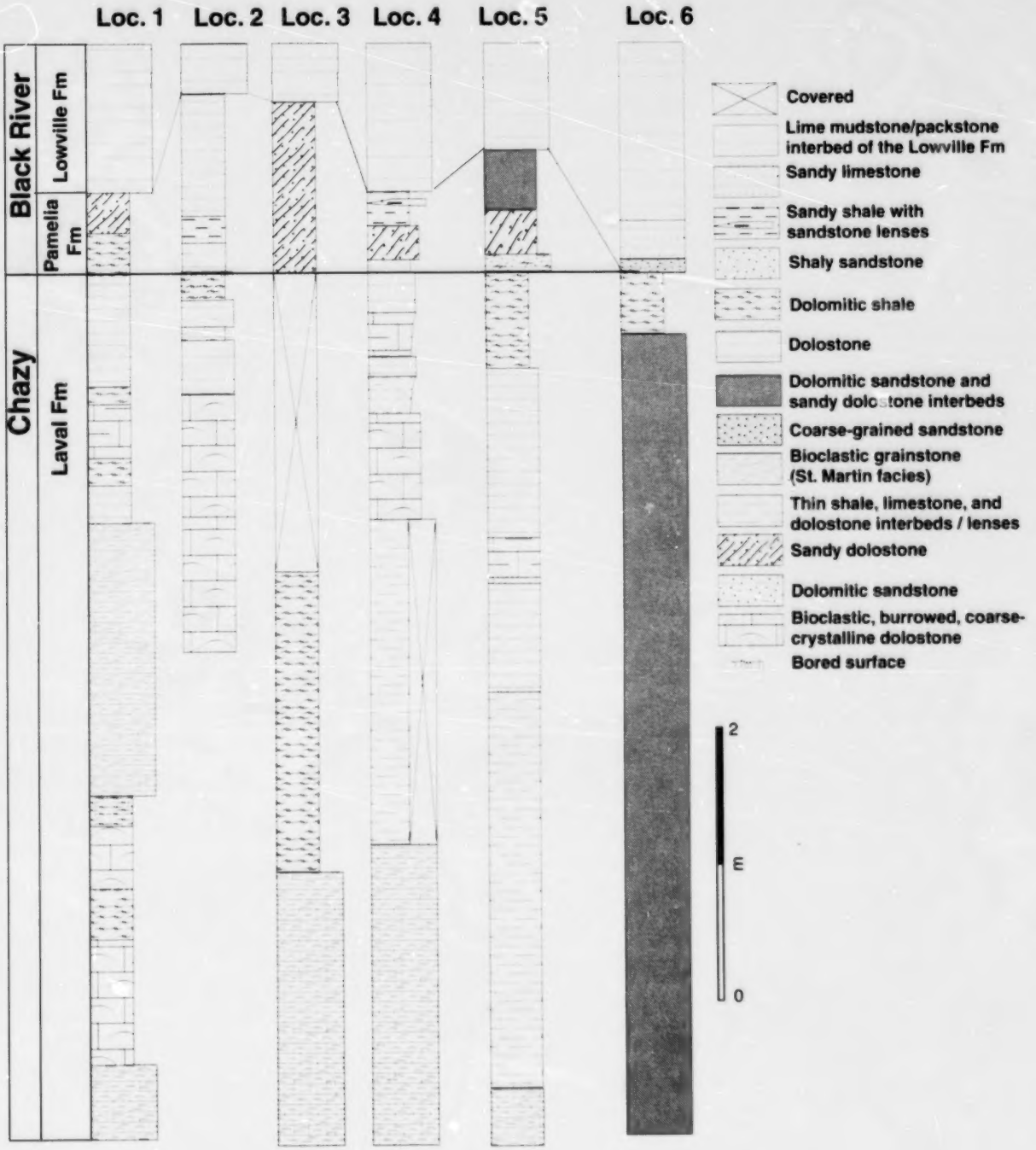


Figure 3. *Lithostratigraphic correlation of the sections addressed in this study. The middle part of the Laval Formation at locality 4 ('Loc. 4' represented by the crossed rectangle) is not exposed, but redrawn from Hofmann (1972). Note that the Chazy–Black River contact is bored at localities 2, 5 and 6, undulating at locality 1, and sharp in locality 4. This contact is covered at locality 3, but morphology of the field exposure suggests that the covered section is similar to the underlying dolomitic shale of the Chazy strata.*

unidentifiable bioclasts, as well as horizontal burrows. The three lithofacies are interbedded (Fig. 3) suggesting that the described dolostone lithofacies is part and parcel of the Laval Formation. At locality 1, the contact with the overlying Pamelia Formation is marked by an undulating boundary overlain by a light, greenish-grey dolomitic shale that grades upward into a medium- to fine-grained crystalline sandy dolostone. The latter contains thin (3–4 cm), medium to dark grey lenses of fine crystalline dolostone in its middle part. The lower dolomitic shale of the Pamelia Formation together with the overlying sandy dolostone lithofacies laterally change from a 60 cm to 120 cm thick interval within about 100 m.

Locality 2: Meloche quarry at Kirkland

The lower part of the section consists of thickly bedded dolostone lithofacies lithologically similar to that of Laval Formation from locality 1 with phosphatic brachiopod fragments and ostracodes, as well as the Chazyan brachiopod *Rostricellula* sp. This is followed by undulating, thinly bedded, medium to dark grey, bioclastic dolomudstone to wackestone with dolomitic shale interbeds. This lithofacies is unique to this locality, has never been described in the Pamelia Formation, and is considered here to belong to the Laval Formation. Dolomitic shale units at the top of the Chazyan section at this locality have a bored upper boundary with borings filled by lighter dolostone lithofacies of the overlying Pamelia Formation. The dolostone beds of the Pamelia Formation at this locality are generally similar to those of locality 1; however, mudcracks; microbially laminated, calcareous to pure dolostone; dark grey intraclasts of oolitic grainstone origin; erosional to hardground surfaces; and some burrows are present in locality 2. Oolitic packstone to grainstone lithofacies is reported to occur in the upper part of the Pamelia Formation in eastern Ontario (Salad Hersi, 1997; Salad Hersi and Dix, 1999), and the oolitic intraclasts at locality 2 may represent rip-ups from an eastward wedging-out of such oolitic lithofacies unit.

Locality 3: Miron quarry, Montréal

The Chazy–Black River contact at locality 3 is concealed. The lowest part of the section consists of the typical "St. Martin calcarenites" of Hofmann (1963). This is followed by a thick unit of medium greenish-grey dolomitic shale. The top of this shaly unit is not visible, but the morphology of the section suggests that the shale lithofacies continues up to the base of the exposed sandy dolostone units of the Pamelia Formation (Fig. 3).

Locality 4: Saint-Vincent-de-Paul quarry, Laval

The Saint-Vincent-de-Paul quarry is an old quarry and its section was mentioned in many previous works (e.g. Hofmann, 1963, 1972; Clark, 1972a, b). All these studies follow the oldest description of Hofmann (1963). The oldest beds exposed in this quarry belong to the St. Martin calc-arenite of the Laval Formation. This is followed by a concealed section underlain by bioclastic limestone, shale, and dolostone interbeds termed as the Beaconsfield Member of the Laval Formation (Hofmann, 1963, 1972). This covered unit is followed by medium- to thickly bedded dolostone (Fig. 3, 4) lithologically similar to that described from locality 1, and thus consider to belong to the Laval Formation. Interbeds of dolomitic shale are also present. Fossils recognized from the lowest thick dolostone bed include phosphatic brachiopods, bryozoans, crinoids, and the brachiopod *Rostricellula* sp. The Pamelia Formation at this locality is represented by thin unit of sandy dolostone, sandy shale, and dolomitic sandstone lenses (Fig. 3).

Locality 5: core from Côte Saint-Louis

A core drilled at Côte Saint-Louis spans across the Chazy–Black River group contact. As shown in the section from this core (locality 5, Fig. 3), bioclastic packstone lithofacies of the "St. Martin calcarenite facies" is overlain by thin beds of shale, limestone, and dolostone interbeds lithologically similar to Hofmann's (1963) Beaconsfield Member of the Laval Formation. The latter is overlain by interbedded units of the burrowed dolostone lithofacies recognized in the other localities and dolomitic shale (Fig. 3).

Figure 4.

Field view of the Laval–Pamelia–Lowville formation succession at locality 4 (Saint-Vincent-de-Paul quarry, Laval). Thick to medium beds below the Laval–Pamelia contact are burrowed, bioclastic dolomudstone and/or wackestone similar to dolostone interbedded with bioclastic lime packstone-grainstone lithofacies (St. Martin calcarenite facies of Hofmann (1963)) of the Laval Formation at locality 1.

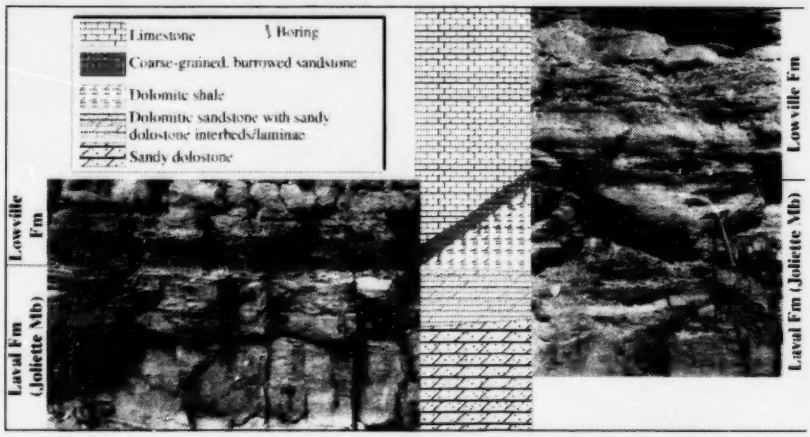
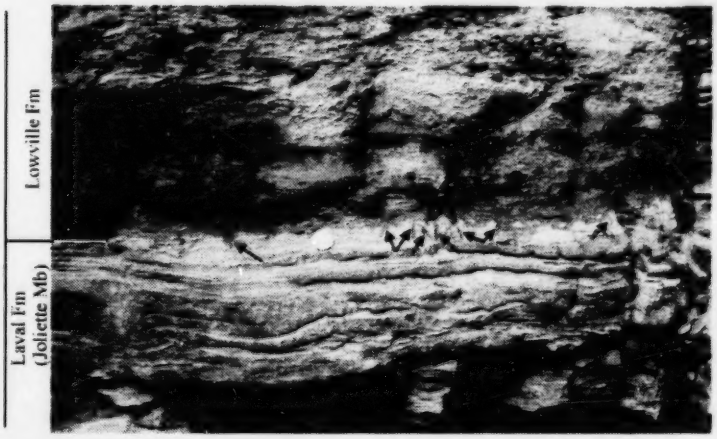


Figure 5.

Correlation of two field pictures from the same quarry (St. Laurent cement quarry at Joliette, Quebec). Note that the thick dolomitic shale beds at top of the Laval Formation (here Joliette Member) present in the photograph at the right side of the figure is missing in the one to the left. The top of the dolomitic shale is bored (see Fig. 6) and overlain by coarse-grained, burrowed sandstone attributed to the overlying Lowville Formation. Here lithology assignable to the Pamelia Formation is missing. This truncation of the upper Laval beds and borings suggest uplifting of the region, and also that the Laval Formation was indurated prior to the deposition of the Lowville Formation. A distance of about 60 m separates areas from which the two photographs were taken.

Figure 6.

Field evidence showing boring features (arrows) at the Laval–Lowville formation contact at locality 6. Here, the dolomitic shale at the top of the Laval Formation (see Fig. 5) is represented by a 1 cm thick layer through which borings are concentrated. The bores are filled by a coarse-grained sandstone similar to the overlying bed and interpreted as a lag deposit during invasion of the 'Lowvillian sea'. Quarter for scale.



The upper contact of the Laval Formation is placed at the top of a dolomitic shale unit with an upper bored surface, and followed by coarse- to medium-grained, light brownish-grey dolomitic sandstone attributed to the Pamelia Formation. The basal sandstone of the Pamelia Formation is followed by thickly bedded, sandy dolostone.

Locality 6: Saint-Laurent cement quarry, Joliette

The section has some lithostratigraphic differences compared to the other sections mentioned above. The lower part of the section consists of thick to thin beds of coarse-grained dolomitic sandstone and sandy dolostone interbeds. Clark and Globensky (1976a) identified Chazyan fossils from these rocks and, because of being lithologically different from the typical Chazy rocks in the Montréal region, they proposed a new name, Joliette Member of the Laval Formation, for these rocks. The uppermost unit of this member is a dolomitic shale; however, this shaly unit is laterally truncated from a 45 cm thick interval to totally absent within a distance of about 60 m (Fig. 5). The upper surface of the dolomitic shale is characterized by well developed borings (Fig. 6). These borings are represented by vertical, oblique, concave-upward, and irregular pillars developed at the top of the dolomitic shale. Mud chips surrounded by borings are present. Where the upper shale is very thin, these borings terminate at the top of the underlying sandstone, and where the shale is completely eroded, no borings were observed. This suggests that the sandstone lithofacies was well consolidated and cemented. This erosional surface is overlain by a 10 cm thick, coarse-grained, medium-grey, burrowed sandstone, followed by bioclastic, sandy limestone of the Lowville Formation.

Dolostone beds or any other lithofacies typical of the Pamelia Formation are missing. The sandstone bed above the bored surface belongs to the Lowville Formation and is interpreted as lag deposit, reworked from the underlying Joliette Member during the marine flooding event that heralded deposition of the Lowville Formation.

REGIONAL CONSIDERATION

In eastern Ontario, Salad Hersi and Dix (1999) indicated that the contact between the Chazyan Hog's Back Formation and the Blackriveran Pamelia Formation (Fig. 2) is marked by a flooding surface with an apparent conformable boundary. The Pamelia Formation is about 44 m thick in eastern Ontario, and regionally correlates well into southeastern and south-central Ontario (Kingston and Lake Simcoe regions, respectively), as well as upstate New York (Salad Hersi, 1997; Salad Hersi and Dix, 1999).

From Montréal to Québec (i.e. northeastward), the lower contact of the Black River strata is unconformable and progressively younger Blackriveran strata onlap older rocks of Chazyan to Precambrian age (Salad Hersi and Lavoie, 1999). This lateral onlapping is accompanied by substantial lithological changes of the Black River strata to the extent that the lithology of the three formations (Pamelia, Lowville, and Leray; Fig. 2) is no longer unequivocally recognizable. For instance, from the Trois-Rivières area to the vicinity of Québec, the Blackriveran Stage is represented by a coarse-grained sandstone (La Gabelle Formation) and/or thinly to medium bedded sandy, dolomitic to pure limestone (undifferentiated Blackriveran strata, Clark and Globensky (1976b), Harland and Pickerill (1982)). Fossils from both the sandstone and the limestone units include species known to occur in the Leray Formation of the Montréal region (Clark and Globensky, 1976b). This suggests that beds equivalent to the Pamelia and Lowville are not represented in the Trois-Rivières area. Farther northeast, (e.g. Montmorency River near Québec), the Black River section is absent, and Trentonian strata of the Deschambault Formation rest nonconformably on Precambrian rocks (Lavoie et al., 1998).

PALEOGEOGRAPHIC SIGNIFICANCE OF CHAZY–BLACK RIVER DISCONFORMITY

The regional and local geological data mentioned above suggest that the Montréal region was a paleotopographic high during deposition of the early Blackriveran Stage (Fig. 7). This is supported by 1) the thinning of the Pamelia Formation from eastern Ontario to the Montréal region; 2) the development of the disconformable erosional to bored boundary between the Chazy and Black River strata described from localities 2, 5, and 6; 3) the onlapping nature accompanied by lithological changes of the Black Riveran strata in the region northeast of Montréal; 4) disappearance of the Pamelia Formation in the

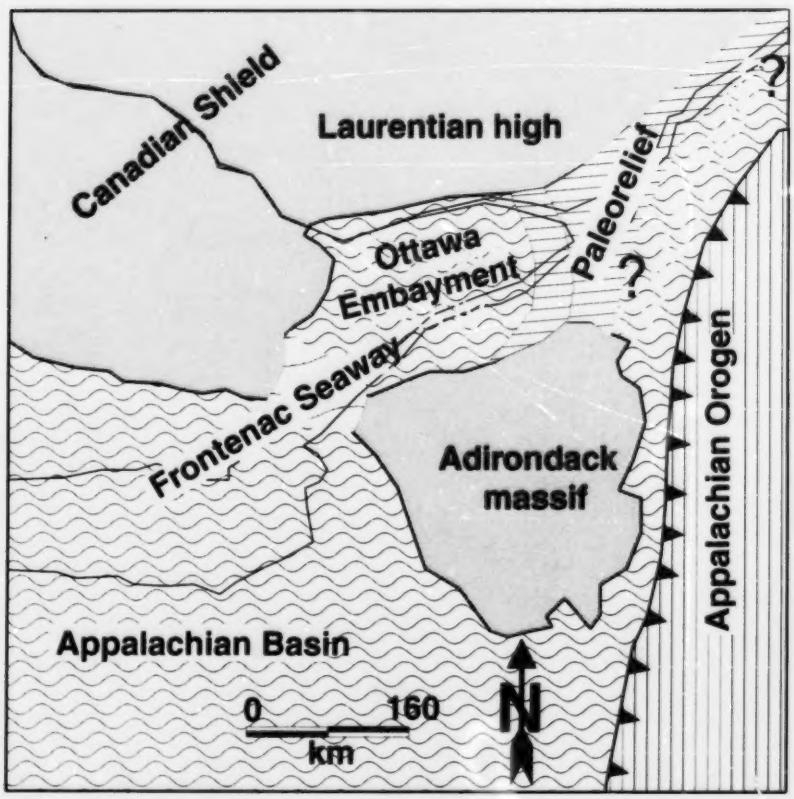


Figure 7.

Paleogeographic reconstruction of the Ottawa Embayment and adjacent regions during deposition of the Pamelia Formation. Most of southwestern Quebec was dominated by a paleotopographic high. This paleorelief created a restricted accommodation space in southwestern Quebec, and consequently reduced thickness of the Pamelia Formation, erosion of the upper Chazy strata, high siliciclastic input, and northeastward lithological changes of the Black River strata (modified from *Salad Hersi and Dix, 1999*).

Joliette area, as well as the Pamelia–Lowville equivalents in the Trois-Rivières area; and 5) the angular unconformity between the Chazyan and Black Riveran strata in the Trois-Rivières area (Roliff, 1967). The paleorelief was becoming more pronounced northeastward, and the sea reached the Québec area during deposition of the Trentonian Deschambault Formation.

This paleogeographic setting supports the interpretation that the Ottawa Embayment was a shallow semirestricted embayment during early Blackriveran time (deposition of Pamelia Formation), and evolved to more open marine shelf environments (post-Pamelia deposition, Salad Hersi and Dix, 1999; Salad Hersi and Lavoie, 2000). The Ottawa Embayment, at the time of the Pamelia Formation deposition, was bounded to the north and west by the Canadian Shield, to the southeast by the Adirondack massif, and, to the east, by the above-mentioned paleorelief in the Montréal area. This paleorelief acted as a positive structural corridor between the Laurentian high of the Canadian Shield and the Adirondack massif (Fig. 7). Evidence of major faulting events from late Precambrian to Late Ordovician was documented by St. Julien and Hubert (1975), as well as Lavoie (1993). Although the earliest development of the Beauharnois anticline is usually considered to be Late (or latest) Ordovician (*see* Bernstein, 1991), these tectonic activities may indicate differential movements along fault-blocks in the Montréal region, and possibly an incipient upthrow of the Beauharnois anticline by the end of the Chazyan or early Blackriveran stage.

Despite differences in thickness, lithological similarities between post-Pamelia formations of the Ottawa and Montréal regions are well recognized (Clark, 1972a; our observation). This suggests that the Ottawa Embayment became fully connected with the eastern sea by the beginning of Lowville Formation sedimentation (Salad Hersi and Dix, 1999).

CONCLUSIONS

Our mapping of Middle to Upper Ordovician strata around Montréal led to the recognition of an unconformity between the Chazy and Black River group strata. The contact is characterized by an eastward pinching out of the lowest Black River strata (the Pamelia Formation); erosion of the uppermost Chazy strata below the boundary; borings along the contact; and a thinly bedded, coarse-grained basal sandstone attributed to either the Pamelia or Lowville formations (lag-deposit) where the former is missing. Dolostone beds in the upper part of the Chazyan Laval Formation and the overlying Blackriveran Pamelia Formation appeared to be similar for previous workers thus allowing an arbitrary placement of the contact between the two formations; however, our study shows that dolostone beds of the Chazy strata are moderately to well burrowed, medium brownish grey, coarse-crystalline, and mostly bioclastic. Lenses and irregular bodies of bioclastic lime and/or dolomitic packstone are locally present. The dolostone units of the Pamelia Formation are light (locally greenish) grey, fine to medium crystalline, locally microbially laminated, mudcracked, and sandy. Thin medium grey lenses of fine crystalline dolostone are locally present within the thick dolostone beds of the Pamelia Formation. This field discrimination of the two dolostone beds allowed us to better position the Chazy–Black River contact.

The Pamelia Formation is up to 44 m thick in eastern Ontario with an apparent conformable contact with the Chazy strata. The upper Black River strata (Lowville and Leray (or Chaumont in eastern Ontario) formations) are easily recognizable across Quebec–Ontario, but are thinner in Quebec; however, in the northeastern part (i.e. from Montréal to Québec) progressively younger Blackriveran strata onlap older rocks (Chazyan to Precambrian). This lateral onlapping is accompanied by substantial lithological changes of the Black River strata to the extent that the lithology of the three formations is no longer unequivocally recognizable. For instance, from the Trois-Rivières area to the vicinity of Québec, the Blackriveran Stage is represented by a sandstone (La Gabelle Formation) and/or thinly to medium bedded sandy, dolomitic to pure limestone (undifferentiated Black River strata, Clark and Globensky (1976b)). Farther northeast (e.g. Montmorency River near Québec), the Black River section is absent, and Trenton Group strata rest unconformably on Precambrian rocks (Lavoie et al., 1998). These variations suggest a more limited accommodation space for the Blackriveran strata in southwestern Quebec, and therefore uplifting (or lower subsidence rate) relative to eastern Ontario. This uplifting is probably due to old structural lineaments reactivation by the then ongoing Taconian Orogeny, and may indicate an incipient upthrow of the Beauharnois anticline.

ACKNOWLEDGMENTS

The senior author thanks to the INRS-Géoressources of the Québec University for offering him a postdoctoral scholarship. We thank to the quarry owners for allowing us map their propeties. This manuscript benefited from the critical review of E. Asselin, of GSC Québec Québec.

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Geological Survey of Canada Project 990001ML